Maramataka

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Introduction

Many ancient civilisations used the heavenly bodies to track the passage of time. The regular motions of the sun, moon and stars, were used as clocks for agriculture, rituals, festivities and other activities (Aveni, 1980, Urton, 1981). Māori used similar methods for their calendrical systems, which were governed by more than one time cycle (Smith, 2011). The first cycle was based on the Sun's annual motion across the horizon from its northern to southern solstice points. The second cycle was based on the movement of the sky during the year, in particular the movement of the stars, whilst the third was based on the phases of the moon (Smith, 2011). These cycles in conjunction with environmental and biological indicators were used to track the passage of time. All of these combined formed a complex system of understandings called the maramataka.

The work of Roberts, Weko and Clarke (2006) showcases and discusses various maramataka from around Aotearoa. They present 43 published and unpublished maramataka from a number of iwi and a preliminary analysis of the meaning of the moon nights. In some versions of the maramataka, the year consists of 10 months with more than one month rolled together under one name, whereas according to Best (1922) the Māori year consisted of 12 months. Roberts et al. (2006) also posit that the number of moon nights varied from 28 to 32. It is suggested that variations in the number of nights/months allows for a necessary intercalation (the addition of extra days, weeks or month) to occur, which enabled the synchronisation of the moon cycles with that of the star risings at New Year. Roberts et al. concur with this concept, stating that an addition of a 13th month may have been done for seasonal synchronicity. These adjustments are not peculiar to Māori but were/are practiced in other cultures, in order to fine-tune their respective calendars.

Matamua (2017) describes the stars used to indicate the various months of the year. Similarly, the arrival of the seasons are also signalled by the appearance of particular stars and/or their constellations. Ropiha (2000) postulates that the names and meanings of the moon nights had ecological knowledge encoded in them, which described the influence of the moon cycle on fishing and planting activities. The recently published work *Living by the Moon*, written by esteemed kaumātua Wiremu Tāwhai (2013), provides detailed descriptions of the localised practices of his own iwi, Te Whānau-ā-Apanui. Drawing upon the knowledge handed down across countless generations, the appropriate activities to be undertaken, such as planting, fishing and ceremonies (or a combination of all three) for each phase and moon night, are outlined alongside their accompanying kōrero or tribal narrative.

Digital technologies today form a critical role in the ever growing research and education space that encapsulates maramataka. The broad and in depth relationship of maramataka with areas such as ecology, the environment and astronomy, yields a wide

interactive space to engage in a variety of digital technologies. In fact, digital technologies have enabled an enhanced experience within the maramataka research and education space. This chapter outlines some of the various digital technologies that maramataka utilises in research and growing understandings of the maramataka.

The Maramataka

The lunar component of the maramataka recognises the different phases of the moon, with each moon phase named with multiple references to such things as agricultural, environmental and ecological information for each phase. *Table 1* gives an example of a maramataka from the Ngāti Kahungunu tribe (Mitira, 1972) and *Figure 1* gives the associated phases of the moon. The example shows 29 names for each night, as well as descriptions of the phase and of relevant food practices for that day or night. Other examples of the maramataka contain similar names with some variations in spelling and ordering. These descriptions to the untrained eye only contain a sparse amount of knowledge on fishing and planting. However, to those with the knowledge, experience and context, these descriptions offer a doorway to a plethora of knowledge. We shall discuss this in more detail later in the paper.

Table 1: *The moon cycle calendar from the Ngāti Kahungunu tribe (Mitira, 1972).*

	Name of night	Relevant description of the night.
1	Whiro	Bad day; the moon is out of sight.
2	Tirea	Bad day; the moon is slightly seen. (New Moon.)
3	Hoata	Good day for planting and fishing, the moon is well shown.
4	Uenuku	Good day for planting from dawn to mid-day; good night for eels.
5	Okoro	Good day for planting from mid-day to sunset, good night for catching eels.
6	Tamatea-a-hotu	Bad day for planting and fishing; sea is disturbed by ocean currents.
7	Tamatea-a-ngana	Bad day for planting and fishing; sea is disturbed by ocean currents.
8	Tamatea-aio	Good day for planting and fishing. (Quarter Moon.)
9	Tamatea-kai-ariki	Bad day for planting and fishing, sea is disturbed by ocean currents.
10	Huna	Bad day; everything is hidden.
11	Ari	Fairly good for planting and fishing; good night for spearing eels.
12	Maure	Fairly good for planting and fishing; good night for spearing eels.
13	Mawharu	Good day, especially for pot cray-fishing.

14	Ohua	Good for planting, good return for all seeds and seedlings.
15	Turu	Fairly good for planting; tide coming in morning and evening, sun setting and moon rising simultaneously.
16	Rakaunui	Good day for planting, but not for fishing (Full moon).
17	Rakaumatohi	Fairly good day; whitebait is moving. (Moon commencing to wane.)
18	Takirau	Best day of all; plant kumara.
19	Oike	Fairly good day for planting and fishing.
20	Korekore-hahani	Bad day, everything is unobtainable.
21	Korekore-whiwhia	Bad day, everything is unobtainable.
22	Korekore-rawea	Bad day, everything is unobtainable.
23	Korekore-piri-ki-tangaroa	Slightly better day, from mid-day to sunset; night for eels. (Moon last quarter.)
24	Tangaroa-amua	Good day for deep sea fishing; white bait is running.
25	Tangaroa-aroto	Good day for deep sea fishing; white bait is running.
26	Otane	Bad day for all things.
27	Orongonui	Bad day for anything.
28	Omutu	Bad day for anything.
29	Mutuwhenua	Worst day of all. (Moon is dead.)

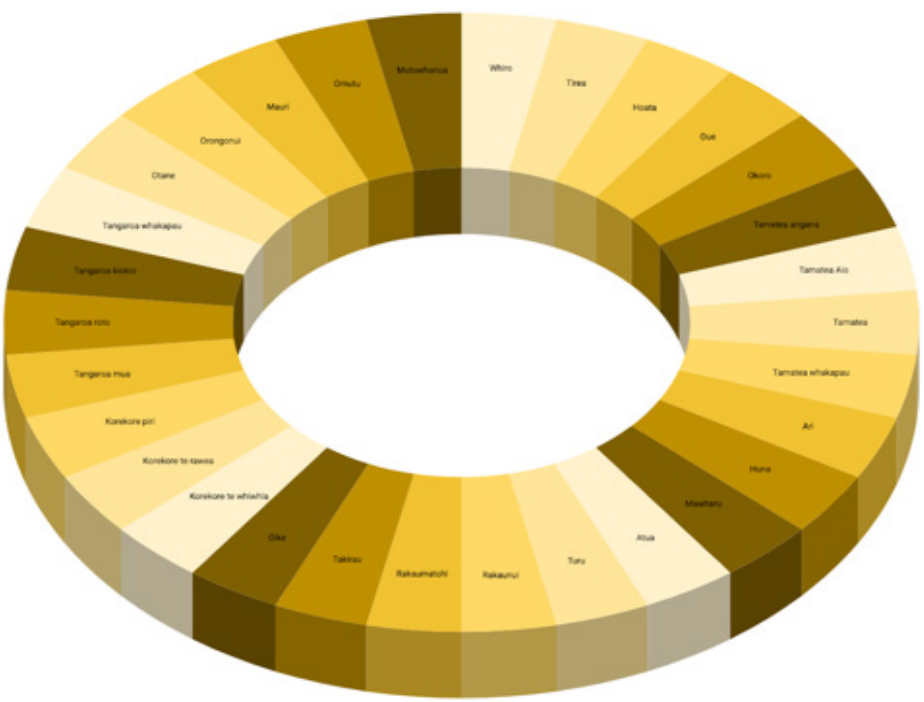

Figure 1: *The moon phases and their associated names.*

Digital technology in the maramataka

In understanding how the maramataka works researchers have embarked upon using digital technologies such as Global Positioning Systems (GPS), Geographic Information Systems (GIS) and Google maps to record and analyse data pertaining to the maramataka. As described above the maramataka encapsulates observations of the celestial, the environment and ecology, which is locale specific and inter-related. This spatial variation thus lends the need to use digital technologies such as GPS and GIS Mapping systems. In addition, there is also, at times, the need to design and develop standalone code for calculating astronomical occurrences such as heliacal rising of stars and moon position and luminosity. We describe here some of these systems and codes that are currently being used in maramataka research.

Geographic Information Systems (GIS) and maramataka

A GIS is defined as "a system for capturing, storing, checking, manipulating, analysing, and displaying data which are spatially referenced to the Earth" (Department of the Environment, 1987, p 132). GIS have the ability to generate:

> 'visual' spatial information which helps people understand relationships between information, concepts, and ideas. Both maps and graphical displays can communicate and present spatial information effectively; showing patterns (detecting change through time), quantifying features, analysing relationships, and visualising hypothetical 'what if' scenarios. 'Seeing' something graphically through pictures or maps has always been a good way to communicate and present information (Manaaki Whenua Landcare Research, 2017)

In a Māori context GIS systems need to be more encompassing to not only record the standard spatial and temporal information, but also aspects such as the relationship with individuals, places, cultural activities, spiritual connections, experience and the spoken word. Māori can employ GIS tools and add their own cultural imprint to existing applications (Pacey, 2005). Moreover, such tools complement the Māori knowledge systems traditionally used to store and transfer knowledge and information.

Current temporal GIS tend to keep track of time via the Gregorian Calendar and the universal 24 hour clock. This can be challenging when documenting and displaying maramataka which has multiple cycles ingrained including the lunar cycle, the tidal cycle, the seasonal cycle, the monthly cycles and specific activities for certain times. The GIS interface can be incorporated into a selection of these cycles to demonstrate how time might otherwise be visualised and queried outside of current standards to align to Indigenous ways of thinking and pedagogy. Some of the features utilised by the Gregorian Calendar and 24 hour clock are not universal, and other factors are salient for keeping time in other cultures. Sense of time is complex; much of it is tied to various events or historical weather events, while much of human behaviour and other species that humans

are tied to are cyclical. Various examples within the environment include the different behaviour of diurnal or nocturnal species, the seasonal migration of birds, the spawning events connected to the lunar phases and the effect of the tidal cycle on travel movements for multiple species in an aquatic environment. Without solid methods of gathering and querying this sort of knowledge, a key component of Māori knowledge will tend to be ignored, lost in translation, or overlooked by outside influences and organisations.

Google Maps API and maramataka

In Aotearoa, the similarities as well as the differences between tribal (and hence physical and geographical) areas are also of interest. For example, horticultural activities feature strongly among the northern tribes such as Ngāpuhi due to warmer climatic conditions and the richness and fertility of the soil; sea fishing among coastal tribes such as Te Whānau-ā-Apanui and Ngāi Tahu due to an abundance of migrational species and ready access; forest foods (birds and rats) among inland peoples such as Tūhoe and Waikato/Tainui tribes, again due to ready access and plentiful bird species, as well as freshwater fish and tuna (eels). Therefore, in the development of multimodal cycles these similarities and differences pose somewhat of a challenge. To represent the temporal predicate we have to set up five cycles of time (maramataka, lunar, seasons, year, tidal) as well as a temporal line in order to separate and classify such cycles. The spatial predicate is represented by the Google Maps API base map as well as a set of layers that represent and locate the activities developed by Māori, i.e., fishing, farming, hunting and others. Finally, the thematic predicate describes the activities by using an ontology, which allows for the classification of traditional ecological knowledge from different perspectives, and the adaptation of the base knowledge to the spatial predicate showing interactions according to temporal cycles. Thus, the user is then given the option of inserting or deleting, activating or deactivating cycles that take place during the maramataka in accordance with their own needs or region.

Heliacal Star Rising and Moon Phase Calculator

In addition to the environmental and ecological indicators, the celestial movements of the sun, stars and moon are also important mechanisms for conveying important maramataka information. Celestial movements of these objects are relatively constant on an extremely long time scale, making them a fundamental component of calendrical systems. At times when conducting maramataka research it is useful to calculate various observable quantities of celestial objects. The luminosity of the moon or the rising time of certain stars is of particular interest. Within the maramataka, stars that had not been seen in the night sky for a short time during year, would be used to indicate a certain time of the year when it reappeared. The reason why these stars are not seen in the sky is because they are obscured by the sun as we orbit around it. The stars will reappear in the early morning sky just before the sun rises as our orbit shifts around the sun. When stars rise in the early morning before sunrise this is called a heliacal rising. Sometimes stars do not need to disappear but need to be observed at certain times and places in the sky to be associated with a time of year.

For example Māori used the heliacal rising of Matariki, known also as the Pleiades. This constellation is sometimes hidden from view for a couple of months and is not visible in the night sky in April and May. When Matariki is seen again in conjunction with a particular moon phase for many iwi this then signifies the Māori new year (Matamua, 2017).

There are other stars that indicate seasons and months of the year. *Table 2* shows stars from Matamua (2017) that represent certain times of the year. Although online calculators and planetariums can enable you to determine when these stars are rising, it is useful to be able to calculate these for large numbers of stars and to view the changing altitude of the stars during the year continuously. In addition, another useful quantity is the luminosity of different objects such as the moon. This enables one to determine a percentage brightness and estimate the moon phase at a particular time, which is particularly useful for the maramataka. For the maramataka, defining the luminosity for a certain moon phase brings additional challenges such as locale specific maramataka, which needs to be accounted for in the code development.

Table 2: *Stars associated with the maramataka (Excerpt from Matamua, 2017, p. 39).*

Te Rua o Takurua	The second of Takurua	Takurua is Sirius	July
Te Waru o Rehua	The eighth of Rehua	Rehua is Antares	January
Te Ngahuru o Poutūterangi	The tenth of Poutūterangi	Poutūterangi is Altair	March

In order to calculate these quantities, Python coding language was utilised due to its relative ease whilst also having the benefit of having precoded computations. PyEphem is a suite of scientific grade astronomical computational algorithms programmed in Python (Rhodes, 2011). Given the date and location, the code can calculate position of the sun, moon, planets and stars. In addition, it is capable of calculating the luminosity of different objects such as the moon. These algorithms can then be utilised to calculate relevant information for the maramataka.

Stellarium

Maramataka lessons have recently been developed for delivery in to schools utilising a planetarium dome. The easy search function in Stellarium locks the moon as a target, which enables a quick zoom into the moon in order to then be guided through daily images of the moon and each moon phase. The planetarium presenter then describes to the audience how the moon phases change with each night followed by a description of specific moon nights and their characteristics and activities associated with it. The easily accessible time option in the programme enables the user to jump from minute to minute, night to night, year to year, quickly showing what the moon looks like at the chosen time. Details of where the lessons were implemented are discussed in the following chapter by Harris *Portable Planetariums in the teaching of Māori Astronomy.*

Discussion

The maramataka is a complex system that utilises the sun, moon, stars, environment and ecology to track time and occurrences. It requires a broad understanding of many facets from the world around us and above us. Due to its multi-layered nature the use of digital technologies such as GIS and Google Mapping have played a fundamental role in recording, displaying and analysing data from all around Aotearoa. In addition, computer programmes have been developed to calculate and validate celestial indicators during the year and to identify phases of the moon at particular times of the month. The use of digital technologies from the calculation of luminosity to the representation of ecological knowledge in GIS has opened a new avenue for viewing the maramataka. This has enabled the real complexities in the maramataka to be shown and brings a new way of looking at the ancient knowledge of the maramataka from the perspective of a modern digital world.

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